The Action of Resin and Allied Bodies on a Photographic Plate in the Dark.

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[Plates 10—12.]

In former papers it has been shown that certain metals, woods, juices of plants, etc., have the property of acting on a photographic plate in the dark; that a similar action is exerted by coal resins and allied bodies is proved by the following experiments.

Ordinary resin or colophony is the solid, remaining on the distillation of crude turpentine, and the substance known in commerce as "amber resin" is ordinary resin slightly purified, and is of a lighter colour.

To prove the activity of these bodies it is only necessary to lay them on a photographic plate in the dark, and afterwards to develop the plate in the ordinary way. The plates used in the following experiments were in almost all cases "Imperial Special Rapid." At ordinary temperatures the action is but slow: the contact of resin and plate would have to be for two to three days in order to obtain a fairly good picture. The amber resin is, however, slightly more active than the ordinary resin. If the temperature be raised, and contact be at 30° to 40° C., the action is much more rapid, and three to four hours is long enough to give a good picture. In fact, in four hours, ordinary resin will give as much action at 40° as it would in three days at 15° to 20°. A still higher temperature cannot be used with safety, for then the resin softens and adheres to the photographic film.

Absolute contact between resin and photographic plate is not necessary, for if the plate be held above the resin the action still takes place, and will, in fact, pass through a considerable distance. In one case when powdered resin was placed at the bottom of a glass cylinder and the photo plate on the top at a distance of 120 mm., and in another case when the distance was 210 mm., in both cases after 18 hours' exposure at a temperature of 40°, a dark picture was produced. Another experiment which shows this action of resin was made by filling a glass tube, 1 inch in diameter and 10 inches long, and slightly contracted at one end with small pieces of resin, the tube being held in a horizontal position, and a photo plate placed vertically at 1 mm. from the open end of the tube. On passing a slow current of air through the tube, which was maintained at 40° C., a dark

indication of where the air struck the plate was produced in two hours. On continuing to pass air through the tubes the activity of the resin gradually decreases, but if the resin be taken out and again broken up its activity is restored.

If the tube containing the resin instead of being straight is bent at a right angle, and a photo plate be placed below the bend, on passing a slow current of air through the tube a large amount of action is produced upon the plate.

The presence of oxygen appears to be necessary for the action to take place.

Two slabs of resin were placed separately in two desiccators: one was filled with dry air and the other with dry carbon dioxide; a photographic plate was fixed at 1 mm. below the resin plate, and both desiccators were kept at 40° C. for 18 hours. It was then found that, although considerable action had taken place in the desiccator filled with air, none had occurred in the one filled with carbon dioxide.

A very marked and important character of this action of resin is that it is not able to pass through the thinnest sheet of glass or mica or aluminium. Glass 1/200 inch thick and mica 1/750 inch thick absolutely prevents the action passing through. This seems to separate this action from others of a somewhat similar character.

Another important point with regard to the action of resin and other allied bodies is the form of the shadow which they produce. If, for instance, a glass screen is placed in front of a piece of resin on a photo plate the shadow is not bounded by straight lines, but the action, like that of a vapour, creeps in behind the screen, and in time meets from both sides. To prevent this action arising from any side action of the resin plate, a glass tube was filled with resin and directed against the centre of the screen. The experiment was repeated with the same apparatus, and a copper screen and ordinary light. Fig. 1 (Plate 10) shows the effect produced in the two cases.

With regard to other properties of the resin plate, a thin plate acts as energetically as a thick one; thus a plate only 0·017 inch thick gave a picture of the same density as one 0·29 inch thick.

To obtain a suitable slab of resin for experiment it is best to melt the resin and cast it on a bright metal plate, and afterwards, to free the surface which has been in contact with the metal from air-bubbles, to pass a gas flame over it.

Another way of using resin for experiments is to dissolve it in alcohol and saturate a card or paper with the solution and allow it to dry. Even very dilute solutions may be used: a card which has been soaked in an

alcoholic solution containing 0·25 per cent. of resin will give a dark picture, and with solutions of only 0·125 and even 0·086 per cent. of resin, faint pictures may be obtained. Again, another way of using resin is to pour the alcoholic solution on to a glass plate and allow it to dry there. There are, of course, other solvents which may be used in place of alcohol.

A card prepared with an alcoholic solution of resin was placed in the dark slide of a camera, and the light of an arc lamp focussed upon it for five minutes. The card was then put up with a photo plate at 55° for one hour. A good and dark picture of the arc was obtained.

If resin be heated to a temperature of 40° to 50° for a short time it does not affect its activity, but if the heating be continued for 20 or 30 hours it slightly diminishes it. At higher temperatures the action is more marked; for instance, at 140° the activity of the resin is much decreased after only four hours' heating, and, although resin may be fused without appreciably diminishing its activity, still, if it be kept in a liquid state for three or four hours, its activity is much decreased. An interesting experiment is easily made with a slab of resin owing to its brittleness. A weight placed on the slab cracks it in all directions; this can be slightly warmed on the under side so as to prevent its falling to pieces, and then on putting it up with a photo plate for a short time a dark picture of the cracks is obtained (fig. 2, Plate 11). Another interesting experiment shows that the activity existing in resin can be transferred to a non-active body, making it as active as the original resin. A glass vessel was nearly filled with crushed resin, and a piece of inactive Bristol board placed on the top of it, at a distance of 5 mm. above the resin. This was left for a week at ordinary temperature, then on putting the Bristol board in contact with a photo plate at 55° C. for five hours a dark picture was obtained.

There are other ways in which this action of resin may be diminished or destroyed; for instance, by the action of sulphur dioxide. A slab of resin was broken into two pieces; one was placed for five minutes in a saturated solution of sulphur dioxide, then very thoroughly washed and dried; the other piece was treated in the same way, but with water alone, and both pieces were put up at 40° for 18 hours. The one which had been washed with water alone gave a dark picture, and the one treated with the sulphur dioxide gave no picture.

It has been shown in a former paper that wood, after exposure to sunlight, has its power of acting on a photographic plate in the dark much increased, and that this increase of activity is not permanent, but gradually passes away. Resin acts in the same way: expose it to sunlight or to the arc light, and then bring it in contact or proximity to a photo plate, and it will be

found that its activity has been greatly increased. Fig. 3 (Plate 11) shows the picture given by the resin in its ordinary state, and after exposure to the arc light for half an hour. In one experiment a slab of resin was exposed to a bright July sun for 5 seconds, and this caused no increase of activity; but exposed for 15 seconds and a slight increase occurred, and after an exposure of 30 seconds the activity of the slab had greatly increased; but on a still longer exposure no further increase took place, so that in about 30 seconds the resin was charged to its maximum amount. Another experiment, when the exposures were for 1 minute, 5 minutes, and 15 minutes; the 1 minute and the 15 minutes gave similar results. If the arc light be used in place of sunlight the same kind of action occurs, only more slowly. In one experiment the exposures were for 5 seconds, 15 seconds, and 30 seconds, and no marked increase of activity took place, but after 60 seconds' exposure a great increase was evident. With another sample of resin exposed to an arc light it was found that it required 5 minutes' exposure to obtain its greatest amount of activity.

If amber resin, in place of ordinary resin, be used, it requires a longer exposure to light to charge it to its greatest amount. Resin is, however, a body which varies so much in composition and constitution that exact measurements cannot be relied on for different specimens, and the above experiments are only intended to show the nature of the action which occurs. The effect of heat on resin in its ordinary state has already been described; if, now, a resin slab, charged to its maximum by exposure to light, be heated to 55° for only one and a-half hours, all this extra activity is destroyed and it returns to its original state of activity.

This increased activity induced by light acts generally in the same way as the original activity of the resin: it is destroyed by sulphur dioxide and does not pass through glass, mica, etc. In all cases of stimulating resin by the action of light a short interval occurs after the application of the light and before the increase of activity begins; when once begun, the increase takes place rapidly and it soon becomes charged to its maximum, so that longer exposure produces no further increase of its activity.

In order to ascertain which rays of the spectrum were most active in producing this change, a spectrum obtained from an arc lamp, with a quartz prism and lens, was allowed to fall upon a slab of resin for one and a-half hours, and this gave, after contact with a photo plate for two hours at 40° C., evidence of action having taken place where the blue rays had fallen on the resin and not elsewhere. On placing slabs of resin in double bell jars with different coloured liquids, the blue, a solution of ammonia sulphate of copper, and the red, potassium bichromate, it was found that, even after an

exposure of one hour in strong diffused light, the resin which had been exposed to the blue light had been strongly acted on, and gave a good dark picture, while the one exposed to the red light gave no increase of activity. The amber resin acted in the same way. A beam of blue light or of red light thrown on a slab of resin or a card saturated with resin gave the same results. On exposing resin under different coloured glasses the same effects were produced: after an exposure of one hour to bright daylight, under a blue glass, the resin became very active, under a red glass no change took place, and under a green glass there was only a very slight increase of activity.

It thus appears that the action of light in this respect, on resin, is similar to its action on wood, as described in a former paper. This increased activity of the resin slowly passes off, even at ordinary temperatures, on keeping in the dark or in red light. A slab was exposed to the arc light for one hour and then cut up into eight pieces. One piece was put up with a photo plate at once at 40° for two hours: it gave a good dark picture; the other pieces were kept in the dark, at ordinary temperatures: after three days a piece was tested, the picture it gave was only slightly lighter than the former one. After nine days, again, a loss of activity had occurred and the same was the case after 18 days. The experiment was carried on for nine months, and at the end of this time although the picture it gave was much fainter than the first one still it was slightly darker than the picture it would have given before exposure. If the resin be only slightly stimulated by exposure to bright daylight, the same gradual decrease of activity was traced. In red light the decrease was apparently the same as in darkness.

Although glass and some other bodies are opaque to the action of resin, porous bodies, of course, allow the action to pass through; for instance, with ordinary paper, if a slab of resin be placed behind it, a very good sharp picture is obtained; if, however, the paper be highly glazed and dressed, it is perfectly opaque. With ordinary papers interesting pictures, showing their structure and water-mark, and stencil pictures are easily obtained.

If paper be treated with different substances in solution, it is made more or less transparent. As a general rule it would seem that acid salts, such as the sulphates, which do not act on the photographic film, make a paper opaque, but that neutral salts do not alter its transparency. If a paper be dried by warming it, it becomes rather less transparent.

The principal constituent of resin is said to be an acid, known as abietic acid. It is not a body which has been very thoroughly examined, but it has the property of acting on a photographic plate in the dark to a remarkable extent. It can be obtained by dissolving resin in alcohol and passing hydrochloric acid gas into the solution; the acid then separates out in a

crystalline form. By repeating this process it may be purified, and will then have a melting-point of 156° C. It is with an acid so prepared that the following experiments have been made. If a small glass vessel be nearly filled with the crystalline acid and a photo plate be laid on the top, not touching the acid, at ordinary temperatures, after two hours no action will have occurred, but after 18 hours the plate will give a strong dark picture. If, however, the acid be kept at a temperature of 40°, then a fairly good picture can be obtained in two hours, and with longer exposure a very dark one.

Thus it acts in the same way as resin, and has about the same amount of activity. Exposed to sunlight or to the arc light, its activity is much increased. Exposed to the arc light for an hour, it gives a good and dark picture, and even on an exposure of half that time a picture only slightly lighter is obtained; in fact, in little more than half an hour it is charged to its maximum amount. Light acts upon it as it does on resin.

The acid dissolves readily in alcohol, and if the solution be allowed to evaporate on a glass plate, it gives a film suitable for experimenting with. Paper saturated with the solution becomes very active. The acid also dissolves in ether, benzene, chloroform, etc., and behaves in the same way as with an alcoholic solution.

If the acid be heated to 100° it slowly loses its activity; after eight hours' heating the picture it gives is only slightly fainter than before heating, but after 56 hours' heating it has become much fainter, and after being heated for 152 hours it has lost entirely its power of acting on a photo plate.

If the acid be fused it becomes quite inactive, but its activity is restored if it be powdered, or if its surface be rubbed with sand-paper—in fact, if the smooth surface be broken up. If exposed to sunlight or to the arc light its activity is much increased, and different coloured rays affect it as they do resin. Exposed under blue or white glass to six hours' sunshine it gives a dark picture, but under a red glass only a faint one. All the metallic salts of this acid are entirely without action on a photo plate: neutralise a solution of the acid with potash or soda and its activity has gone, and there is the same loss of activity with the copper and the lead salts, whether in solution or in the solid state. Decompose the metallic salts and the liberated acid is as active as before.

To purify the acid the lead salt, which is very insoluble even in alcohol and other organic liquids, was boiled several times with pure alcohol, and afterwards treated with sulphuretted hydrogen, the acid well washed and dried, and recrystallised from alcohol, and it was found to be quite as active as before this treatment. Another specimen of the acid was treated with

an insufficient amount of alcohol to dissolve the whole of it. After boiling and digesting for a considerable length of time the undissolved acid was filtered off, washed, and dried, and was found to be quite as active as before this treatment, so that neither process of purification affected the activity of the acid. If the fused and inactive acid be simply exposed to light it will again become active. If the activity of turpentine depends to any appreciable extent on the presence of abietic acid, then if it be treated with an alkaline body its activity should be decreased. Turpentine is known to be a very active body, and a plate placed about one-eighth of an inch above it will, even at ordinary temperatures, in three hours give a black picture. Some turpentine was allowed to stand for 18 hours with a small amount of solid caustic potash; this was then filtered off, and the liquid distilled and put up with a photo plate for three hours; no trace of action was visible. Another photo plate was placed above the same turpentine solution and allowed to remain for 18 hours; even then only a very faint action took place. Another specimen of turpentine was shaken up with magnesium oxide and allowed to stand for 24 hours. The clear liquid gave a much fainter picture after this treatment. The same occurred when dry sodium carbonate was used, but lead acetate had no action on the turpentine.

Amber, although classed as a resin, differs so much from the substance already described that it was of much interest to ascertain how it would act under similar conditions. It is a remarkable substance, known from the earliest times, and has been used for many purposes.

Quarried at one time, like a stone, it was naturally looked upon as a mineral, but is now known to be of vegetable origin: the exudation of certain trees, probably mostly coniferous ones, which have been buried in the ground for ages. Even in the Green-sand formation some amber has been found. At the present time the principal supply of amber comes from the shores of the Baltic, but a small amount is still picked up on the east coast of this country.

If a piece or pebble of amber, either in its rough state or cut so as to give it a flat surface, be laid on a photographic plate in the dark, no action takes place, even if the contact be continued for 18 hours and the temperature be at 40° to 50° C., thus differing from resin. This has been tried with a large number of specimens from different parts of the world, and with true amber has always been found to be the case.

There are many bodies closely resembling amber in appearance, chiefly resins, which act strongly on the photo plate, and although readily distinguished by an expert in the subject, can easily be mistaken for true amber. It often happens that a piece of amber, after long exposure to a plate, will

develop on it small spots of action; these local actions are produced by fine cracks in the amber, which frequently occur, and it is above the opening of these cracks that the action takes place. If the amber be laid for a minute on a hot surface the opening of the cracks fills up and the action ceases. This resembles the action of resin, and apparently points to the collection of volatile matter within the cracks.

Another way of showing that, although a flat surface of amber does not act on a photo plate, still there is a trace of active vapour connected with it, for if powdered amber is placed in a glass dish with a plate above it, but not necessarily touching the powder, after the usual exposure a dark picture is produced. Amber, as is well known, is practically insoluble in alcohol, but in all cases a very small amount of some substance dissolves out of amber; now if this substance be collected by filtering the alcoholic solution and evaporating it to dryness, the residue is found always to be a very active body and gives a dark picture, thus a lingering indication of the amber's origin seems to be indicated.

Following the same line of experiments as that applied to resin, amber was exposed to sunlight and to the arc light, and its activity was found to be much increased. Four pieces of amber were exposed to sunlight for different lengths of time, namely, for two, three, five, and seven hours. After two hours only a very faint picture was produced; after three hours the picture was much darker and strongly outlined; after five hours it was still darker, and after seven hours a very dark picture was produced. The arc light acts in the same way. A specimen of good amber was cut into four pieces, and all of them were exposed at the same time, at a distance of 9 inches from the arc light: one piece for one hour, another for two hours, and the other two for respectively four and six hours. All of them were afterwards put up with photo plates at 55° C. for 18 hours. The amber exposed for one and for two hours did not act on the plate; the one exposed for four hours gave a considerable amount of action, and the one exposed for six hours gave a dark picture. Another experiment of the same kind showed that the amber became slightly active in two hours, and was much increased after four hours, but after six hours and even after ten hours but very slight increase of activity occurred. As amber is a body which varies so much in constitution and composition, the action of light on it will vary slightly with every sample. For instance, five pieces of amber, all from different sources, were exposed at the same time for three hours to an arc light: two of them gave dark pictures, two only faint pictures, and one no picture at all.

Amber, like resin, if stimulated to increased activity by the action of

light, gradually loses this increased activity on keeping it in the dark or in dull light, but for a long time retains a slight amount of its increased activity. If, however, the amber be heated, this loss of activity takes place rapidly, even when heated to only 50° C., and if a flat surface of it be brought in contact with a piece of heated metal for one minute the amber loses entirely its activity. It has already been shown that resin is stimulated especially by the blue rays of the spectrum; the same thing occurs with amber. Specimens of different ambers were exposed both to sunlight and to arc light under different coloured glasses, and it was always found that under the blue glass it became strongly active and that under the red glass it remained quite inactive, and if black glass and colourless glass were used the black glass acted like the red glass and the white one like the blue, only rather stronger. When double bell jars with coloured liquids were used in place of coloured glasses, exactly similar results were obtained. One experiment of this kind was continued for four months and gave the same result.

Lignite, jet, and peat have also been tested in the same way as resin and amber. Two specimens of lignite from the Museum of Practical Geology, Jermyn Street: one an ordinary brown coloured piece, the other a sample from Tasmania; both were quite inactive and light did not stimulate them to action; even the alcoholic extract was inactive. Another specimen from Nigeria was also inactive, but one from Bovey Tracey was slightly active, and a specimen of "Brown coal" from Victoria, after an exposure of 44 hours, was found to be also very slightly active. Several specimens of jet from different sources were tried. None of them, if simply laid on a photographic plate and warmed, gave any action, but if powdered and a plate placed at 1 mm. above it, at 55° for 18 hours, gave a faint picture. Again, if powdered jet was extracted with pure alcohol, the small amount of dissolved matter evaporated to dryness gave a dark picture. So that jet, although not in ordinary conditions an active body, still in the form of powder has the property of acting on a photo plate. Light does not appear to have the power of making it active.

Graphite from Ceylon did not act on a photo plate. A specimen of peat was found to have the property of acting on a photo plate, but its activity was not increased by exposure to light.

One other substance belonging to this class of bodies, namely coal, remained to be examined, and it was interesting to find that all ordinary coals, if brought into contact with a photo plate at a temperature of about 50°, were capable of acting upon it and giving a clear and distinct picture; so sharp are these pictures that they may be enlarged five or six times and still show clearly all the

details. Fig. 4 (Plate 10) is the picture of a vertical section of a Nottingham coal enlarged three times. The vertical section of a coal gives usually a more interesting picture than the horizontal section. Figs. 5 and 6 (Plate 11) show vertical and horizontal sections of a Seaham coal. Through the kindness of Dr. Teall and Mr. Strahan, of the Museum of Practical Geology, I have had the opportunity of examining coals from different localities. Taking first the specimens of English coals, they all seem to be active, that is, have the power of acting on the photographic film in the dark. The best way of trying them is, first to saw off a piece from the rough block, and then rub it down first on coarse sand-paper and then on fine, till the surface is flat and true, then on laying this flat surface on a photo plate at about 50° C. for in most cases about 18 hours, but in some cases it may be well to continue the contact for as long as 48 hours, a good picture is obtained. If the coal contains much water, it must be dried, either by heating it for a short time at a temperature of about 40° C. or by drying it over sulphuric acid.

In place of using a slab of coal, it is sometimes convenient to use it in the form of powder, and this is done, as in previous cases, either by simply placing the powder on the photo plate or by filling a small glass vessel with it and placing the photo plate on the top, either in contact with the powder or at a small distance above it. As long as the coal is used in form of a slab and is fairly dry, its action is very uniform, different pieces of the same coal giving pictures of the same density; but when the coal is in powder, a small amount of moisture modifies the density of the picture to a very considerable extent.

The effect of slightly heating a coal is shown by the following experiment:—Four samples of a Seaham coal in powder were treated as follows: One sample was at once put up with a plate, and gave a fairly good picture; another was heated for 24 hours at 100° C., and gave a much darker picture; a third one was heated at 150° for the same length of time, and its picture was much lighter, only slightly darker than the first one; and the fourth sample was heated for 24 hours at 200°, and gave no picture.

In another case the heating was continued for only three hours at 200° and it gave a faint picture. If the drying be effected by placing the powder over sulphuric acid, phosphorus pentoxide, or solid caustic potash, it seems in many cases to increase the activity of the coal to a very considerable extent, so much so that some coals which under ordinary conditions give only a faint picture can be made to give a dark one. But on the other hand there are coals which are not altered by this process of drying. One specimen of coal, a Seaham coal, powdered, was exposed 11 times in a glass vessel over sulphuric acid, each time for 24 hours, without any diminution of its activity;

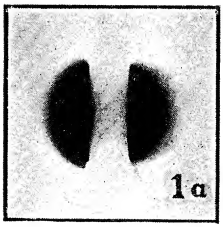
but if the coal was exposed to the air for 24 hours its activity considerably decreased, but was restored by again placing it over sulphuric acid.

Coals exposed to sunlight or arc light do not perceptibly increase in activity, as many other bodies do, nor does the small amount of substance dissolved out of them by boiling alcohol appear to be active.

The following pictures are fair samples of coals from different English beds: figs. 7 and 8 (Plate 12) are both from South Wales. Fig. 9 is a Nottingham coal, fig. 10 a Derbyshire one, and fig. 11 is from Lancashire. In all cases the deposit of vegetable matter in long or short strips or patches is clearly shown and well defined, and the presence of vegetable matter appears diffused through the mass of the coal.

Although there must necessarily be a strong resemblance between coal pictures, still it may prove that a certain specific and recognisable character belongs to coals from different beds. For instance, judging from the few specimens which have been examined, the South Wales coals appear to have their active strata fine and near together, whereas the coal from Derby and Nottingham has active strata which are much thicker and very sharply defined; but considering the small number of experiments made, this may be purely accidental. The pictures, however, clearly show differences in coals; for instance, all the anthracites that have been examined have given pictures different from the foregoing: they are fainter in appearance, the structure they represent is more complicated and the active matter more evenly distributed through the mass of the coal, as shown in fig. 12. There always appear to be cracks in anthracites and these cracks are always white. There is also another curious point with anthracites: if they are dried over sulphuric acid the picture they give is much darker than the picture obtained in the ordinary way, fig. 13. Only a few Cannel coals have been examined: these gave pictures in character like the anthracites but with less detail and not so dark. Fig. 14 is a picture of the well-known Boghead Cannel coal.

From coal plants of different kinds and from different localities no pictures have been obtained. If the soft powder so common in bituminous coals and known as "Mother of Coal" is carefully removed and tested it is always found to be very active. The large amount of diffused action on the top of fig. 4 is owing to this substance; also the fibrous substance so often present and easily removed from coal is also very active, but the hard glistening surface of coal is only slightly active. Of the coals which have been examined, a Boora coal from the Lower Oolite, a Jurassic coal from Mexico, and some Argentine coals and a Tertiary coal from India are ones which have been found to have little or no action on the photo plate. No



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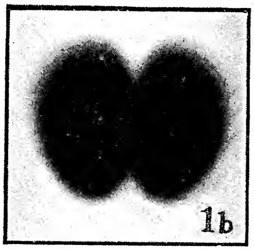

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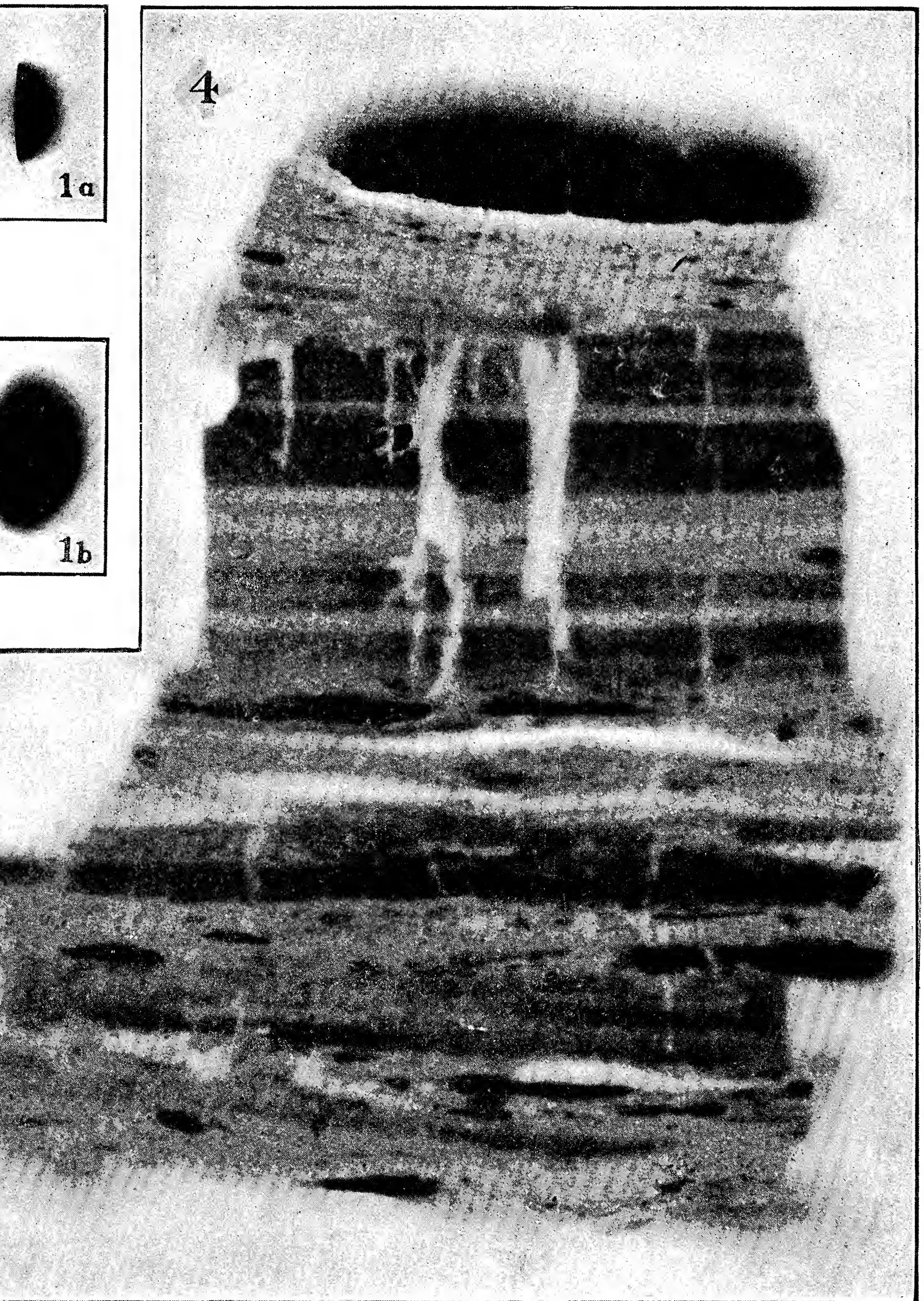

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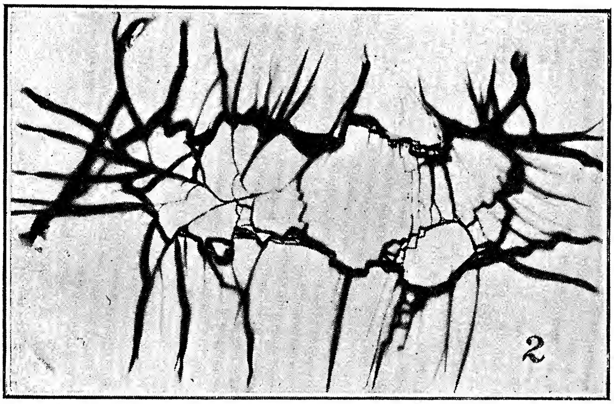
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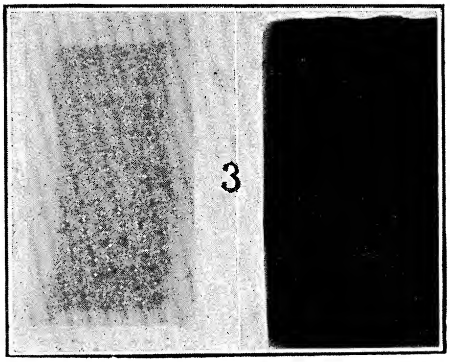
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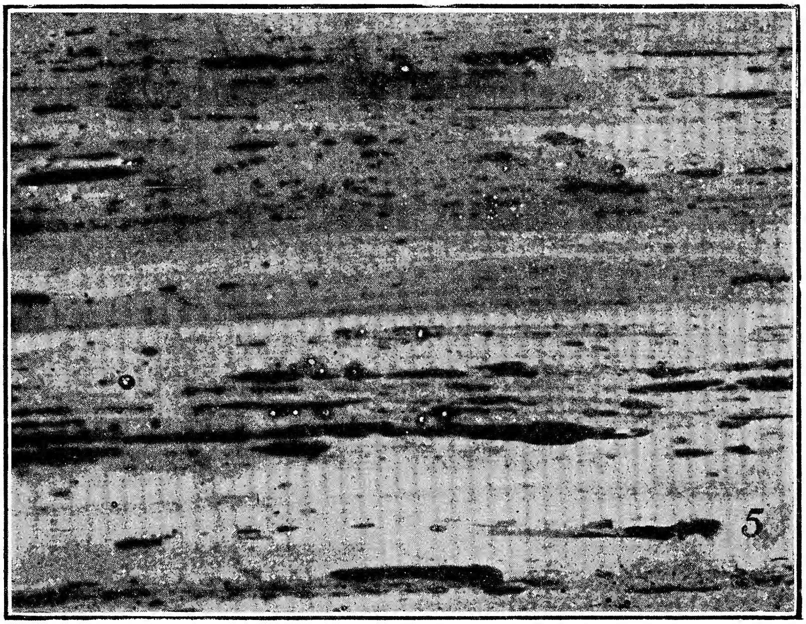
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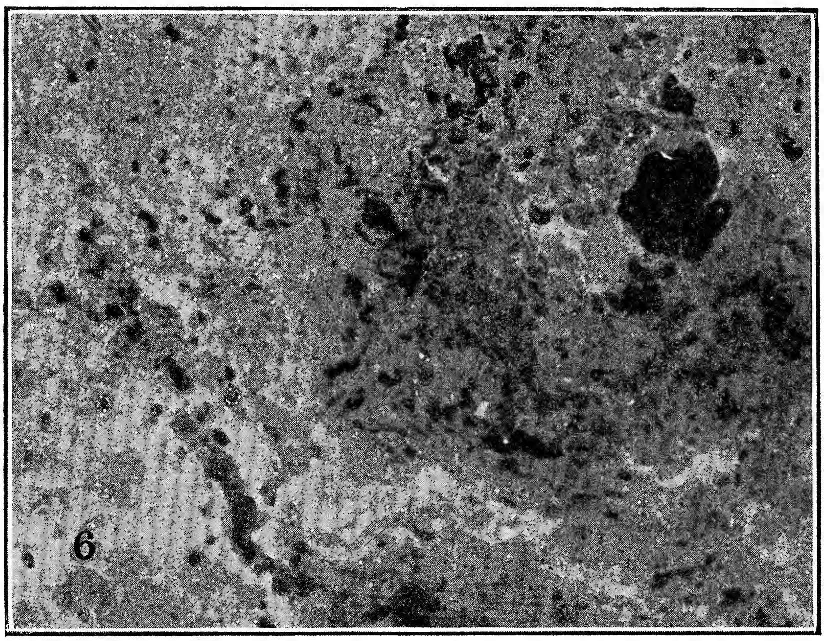
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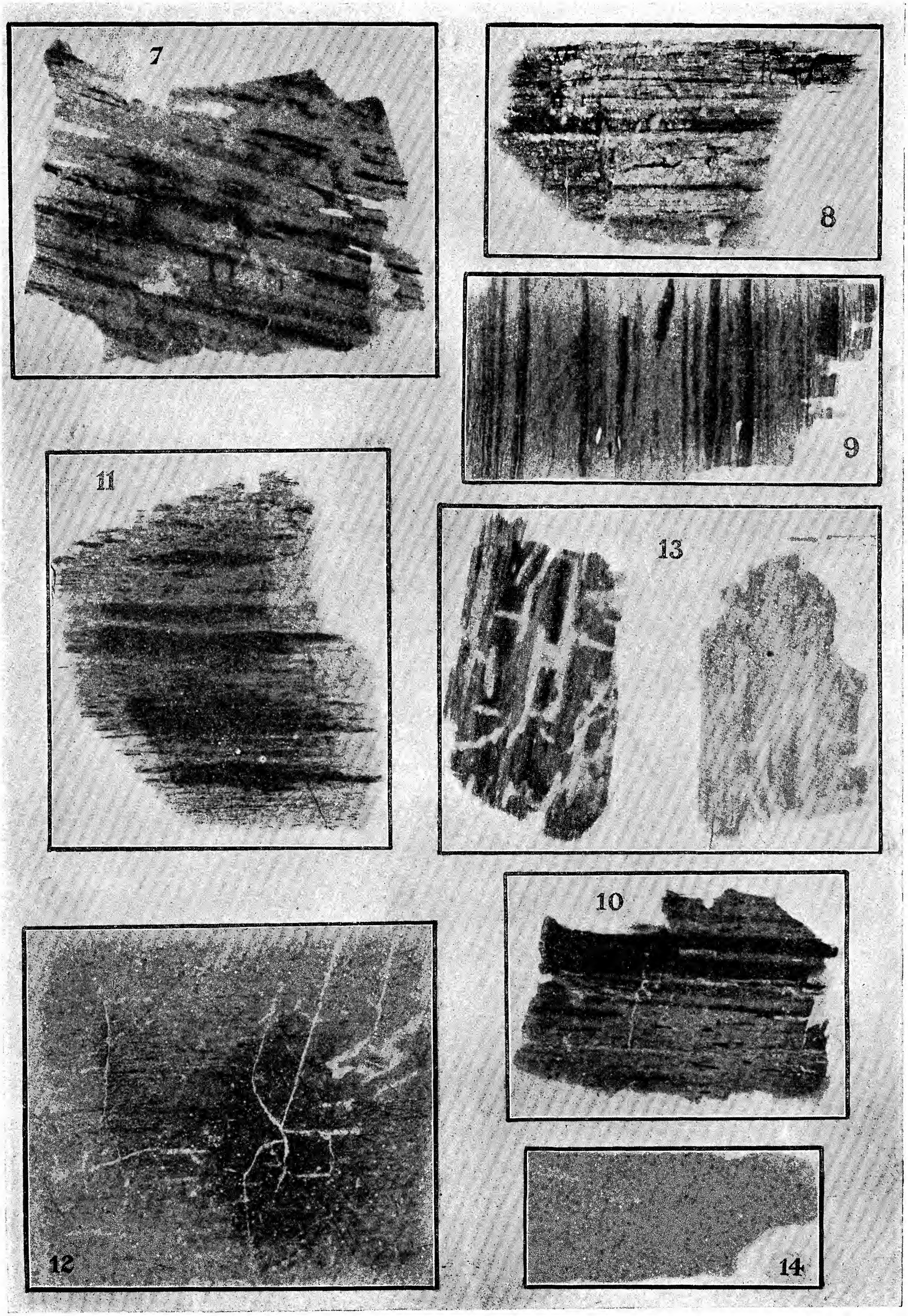
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doubt the long exposure of small specimens in a museum may affect their activity.

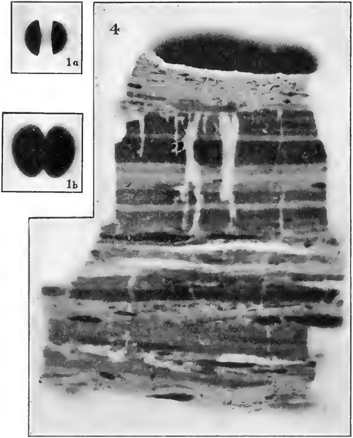
The foregoing experiments indicate the nature and to some extent the results which may be obtained by allowing coal to draw its own picture on a photographic plate, and in the hands of a geologist may help to explain the process of its formation.

With regard to the nature of this action on photographic plates in the dark, it has been suggested in former papers that it is owing to the presence of hydrogen peroxide, and that the effects described can be imitated by means of this body. It now seems that actions of this same kind are obtainable from many other bodies, but still bodies of the same kind, and these additional experiments strongly indicate that the action is produced by a vapour rather than by any form of radio-activity. For instance, it is shown that the shadows thrown by resin are not bounded by straight lines, but curve round a screen; that the action is not capable of passing through glass, mica, or aluminium foil, even of extreme thinness, and does not affect an electrical field. The action can pass along a glass tube, even when it is bent at a right angle, and may be swept out of a tube by a slow current of gas; and, further, an experiment described above shows that the activity of resin can be transferred to a piece of perfectly inactive Bristol board, which will then give a black picture. Further, no action takes place in an atmosphere of carbon dioxide. On the other hand, resin dissolved in an inactive liquid, such as alcohol or petroleum spirit, causes it to become active.

The action which strong light has in increasing the activity of many bodies is important. For instance, it has been shown that pith may be in contact with a photographic plate at 55° for 48 hours and no trace of action is visible, but if the pith be exposed to sunlight for two or three hours it will then give a dark picture. The same action occurs with old printing, with pure india-rubber, etc., and many bodies which under ordinary conditions are but slightly active become very active after exposure to bright light or simply to blue rays.

My thanks are due to my assistant, Mr. Bloch, who has made all the photographs and given me much aid in carrying out the experiments.

The work has been carried on in the Davy-Faraday Laboratory of the Royal Institution.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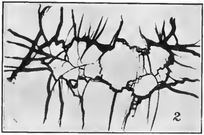

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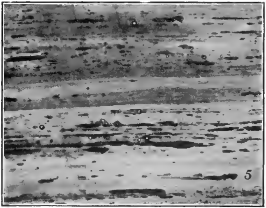

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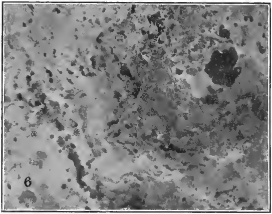

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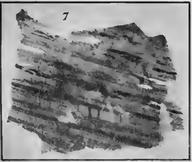
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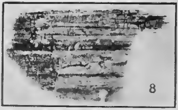
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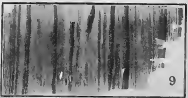
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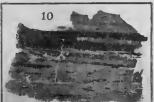
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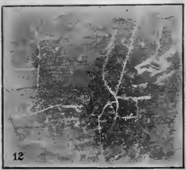
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